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Do new investment strategies take existing strategies' returns - An investigation into agent-based models --

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(2) Model

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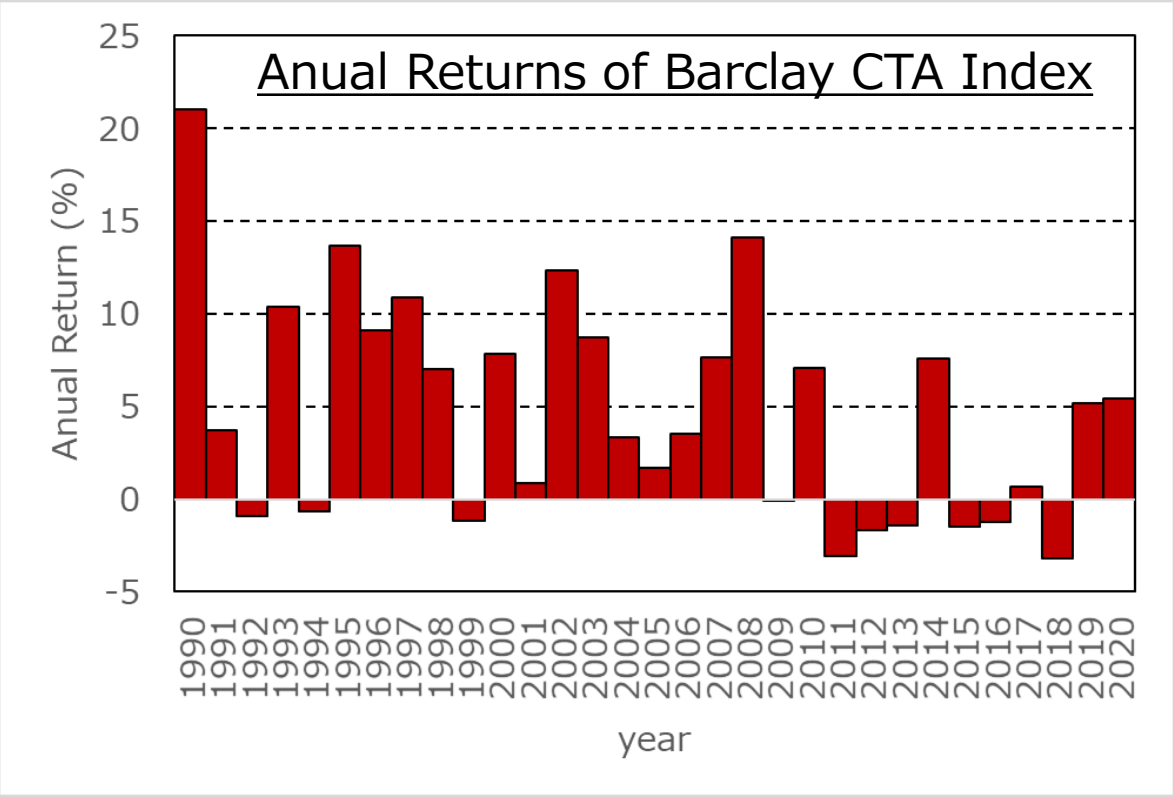
CTAs have not performed (CTA=Commodity Trading Advisor)

CTAs, who mainly trade commodity futures, showed good returns in the 2000s.
However, since the 2010's, they have not performed very well.



https://portal.barclayhedge.com/cgi-bin/indices/displayCtaIndex.cgi?indexCat=Barclay-CTA-Indices&indexName=Barclay-CTA-Index

**It is not solved that the reason why CTAs have not performed.
The reason of good performance before also not understood.**

The reasons why CTAs have not performed

Clenow [2012] reported the following points as reasons for this

(1) the yield of government bonds decreased,

(2) most CTAs utilized similar trend-following strategies and tended to trade at the same time, leading to the increased number of CTAs further impacting market prices,

(3) the variation of investors and investment strategies was diversified by alternative investments spreading,

(4) short-term reversal traders (STRTs) who preyed on CTAs for profit emerged.

But the four points contradict each other

Point (2) implies that CTAs did not perform well due to the number of CTAs increasing, but Point (3) implies that the number of CTAs has relatively decreased.

When one investment strategy fails to work, new strategies, especially those that use new technologies or faster tradings, have tended to be blamed for a long time.

Point (4), should be discussed with particular suspicion

Difficulty of Empirical Study

✓ Since many factors affect price formation, an empirical study cannot isolate the direct effect of new trading strategies on price formation.

Artificial Market Simulation using Agent-Based Model can do

In this study

In this study, the artificial market model was built by adding a CTAA and STRTA to the prior model of Mizuta et al[2016]

CTAA: an agent trend-following (momentum) like as CTA
STRTA: short-term reversal trader agent

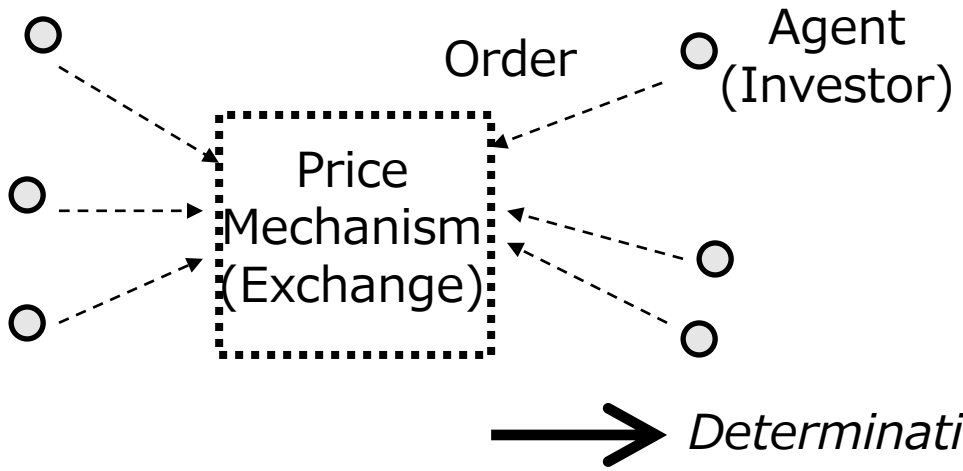
I investigated whether emerging STRTAs led to a decrease in CTAA revenue to determine whether STRTs prey on CTAs for profit.

An artificial market model = an agent-based model for a financial market

Virtual and Artificial financial Market built on Computers

Models Include

Agents (Artificial Investors)
+
Price Mechanism (Artificial Exchange)



Each Agent determines an order by some rules, Price Mechanism gather agents orders and determines Market Price

Complete Computer Simulation needing NO Empirical Data

- ✓ can discuss on the mechanism between the micro-macro feedback
- ✓ can be conducted to investigate situations that have never occurred in actual financial markets
- ✓ can be conducted to isolate the direct effect of STRTs

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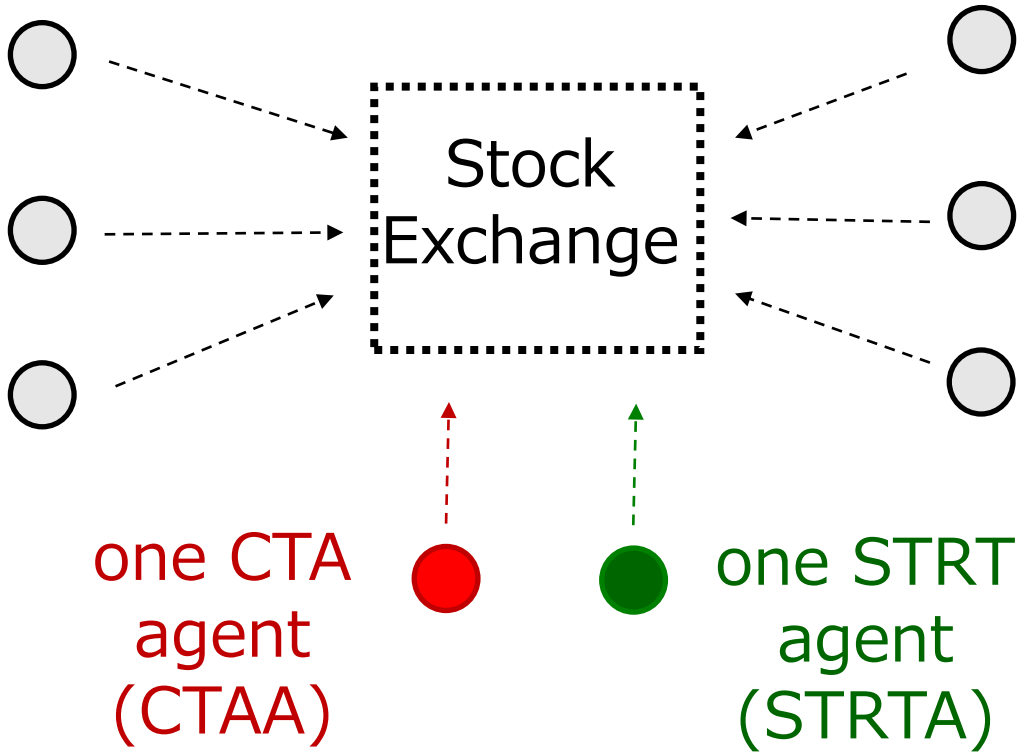
My Model

Normal Agents (NAs) exist 1000 agents

To replicate the nature of price formation in actual financial markets, I introduced the NA to model a general investor.



each 10 time steps, they decide to trade or not

In this study, the artificial market model was built by adding a CTAA and STRTA to the prior model of Mizuta et al[2016]

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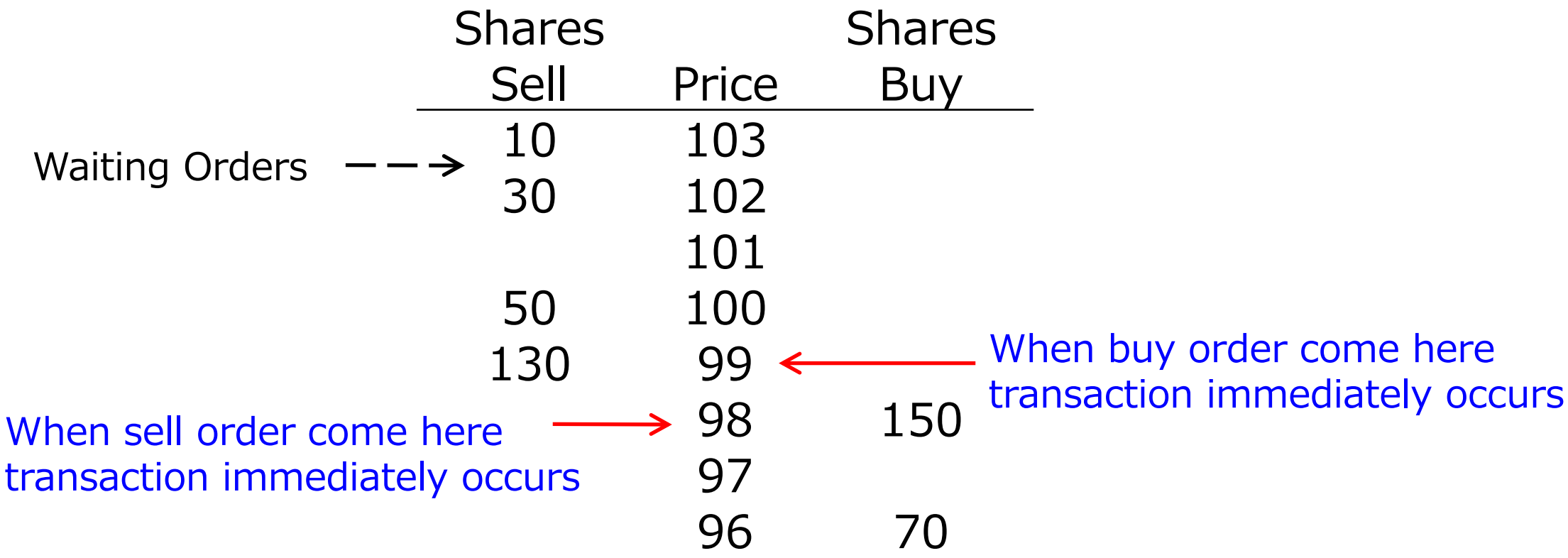
Stock Exchange (Price Mechanism)

continuous double auction



Multiple buyers and sellers compete to buy and sell stocks in the market, and transactions can occur at any time whenever an offer to buy and an offer to sell match.

Normal Agents (NAs)

j: agent number (1,000 agents)
ordering in number order
t: tick time

Historical Return

$$r_{h,j}^{t} = \log P^{t} / P^{t-\tau_j}$$

Technical

Expected Return of each NA

$$r_{e,j}^{t} = \frac{1}{\sum_i w_{i,j}} \left(w_{1,j} \log \frac{P_f}{P^t} + w_{2,j} r_{h,j}^{t} + w_{3,j} \varepsilon_j^{t} \right)$$

Parameters for agents

$w_{i,j}$ and τ_j

Random of
Uniform Distribution

$w_{i,j}$	i=1,3: 0～1 i=2: 0～10
τ_j	0～10000

Fundamental

P_f	Fundamental Price 10000 = constant
P^t	Market Price at t

noise

ε_j^t
Random of
Normal
Distribution
Average=0
σ=3%

Expected Price of each NA

$$P_{e,j}^{t} = P^{t} \exp(r_{e,j}^{t})$$

Fundamental and Technical Strategies

Fundamental Strategy

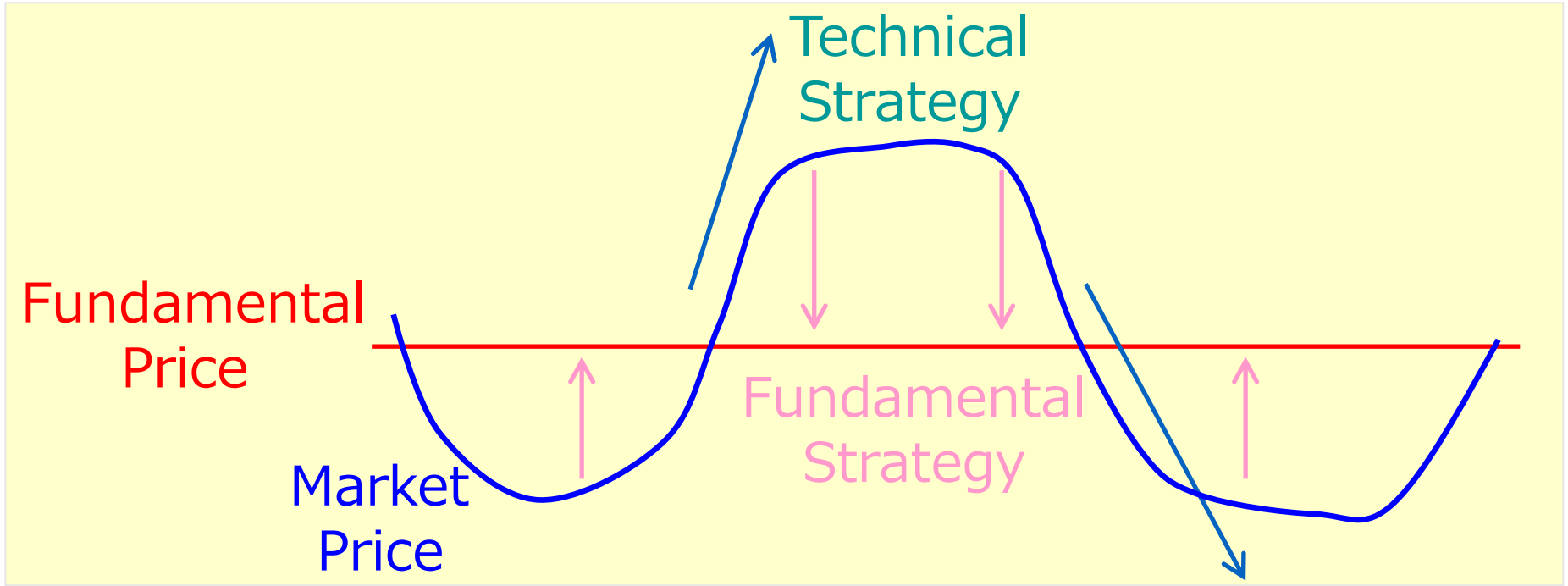
Fundamental Price > Market Price -> Expect + return

Fundamental Price < Market Price -> Expect - return

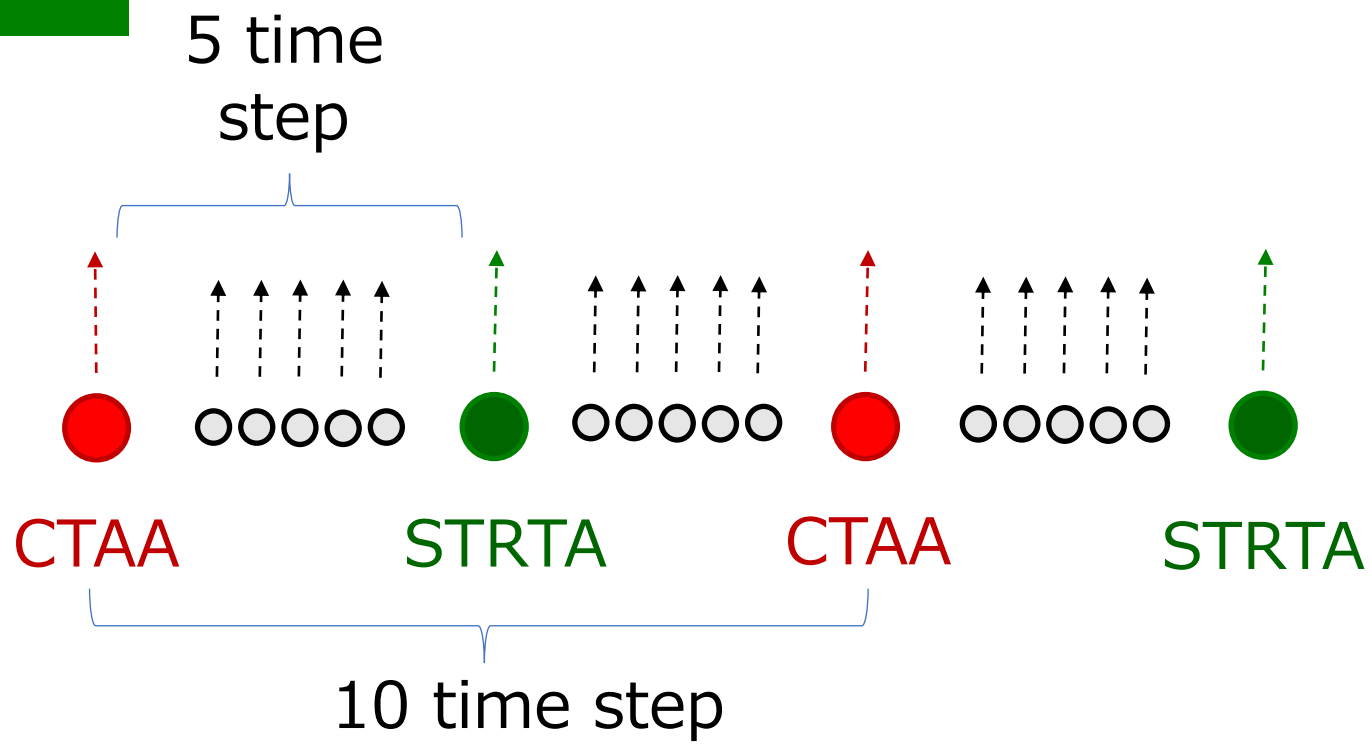
Technical Strategy (Historical Return)

Historical Return > 0 -> Expect + return

Historical Return < 0 -> Expect - return



CTAA and STRTA



They decide whether trade or not at
 CTAA: when t=10000,10010,10020,,,,, (each 10 time steps)
 STRTA: when t=10005,10015,10025,,,, (each 10 time steps)
Only when they need a trade, they place order one share.
(When t<10000, they do not place an order to generate a sufficient number of waiting orders)

CTAA

When CTAA has no share

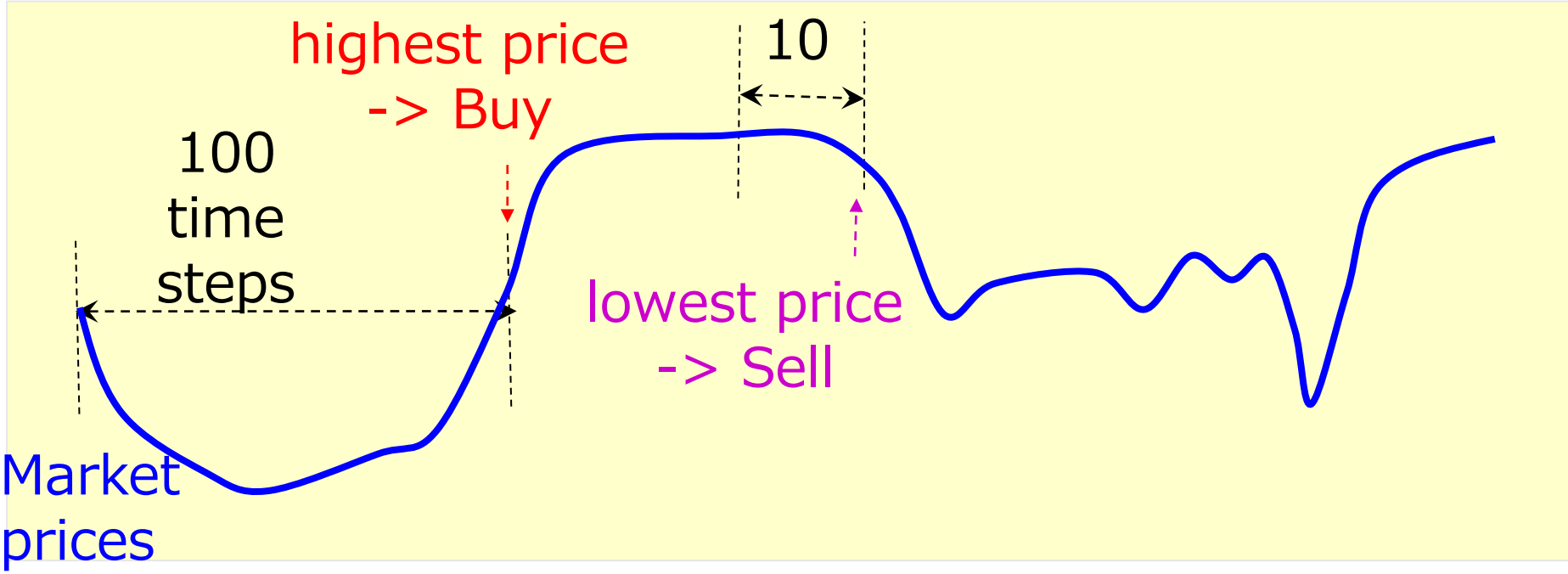
* if historical highest price for 100 time steps -> Buy -> holding +1 share
* if historical lowest price for 100 time steps -> Sell -> holding -1 share

When CTAA holds +1 share

* if historical lowest price for 10 time steps -> Sell -> holding NO share

When CTAA holds -1 share

* if historical highest price for 10 time steps -> Buy -> holding NO share



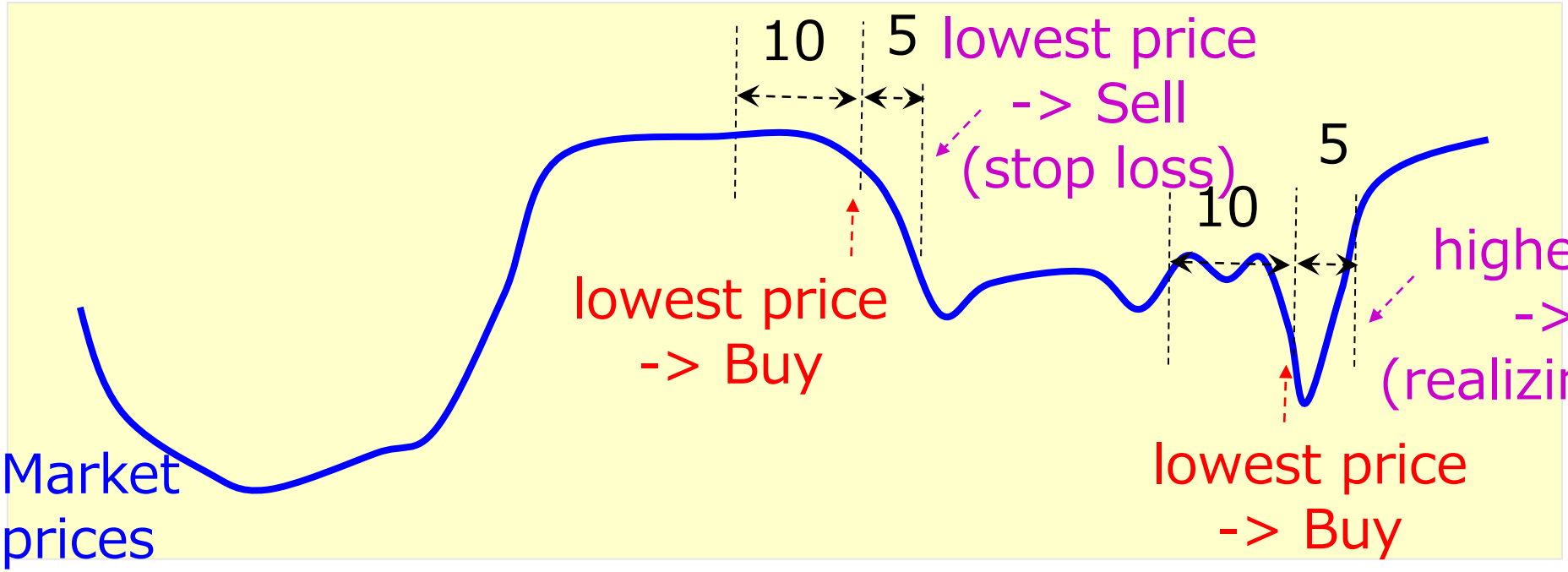
STRTA

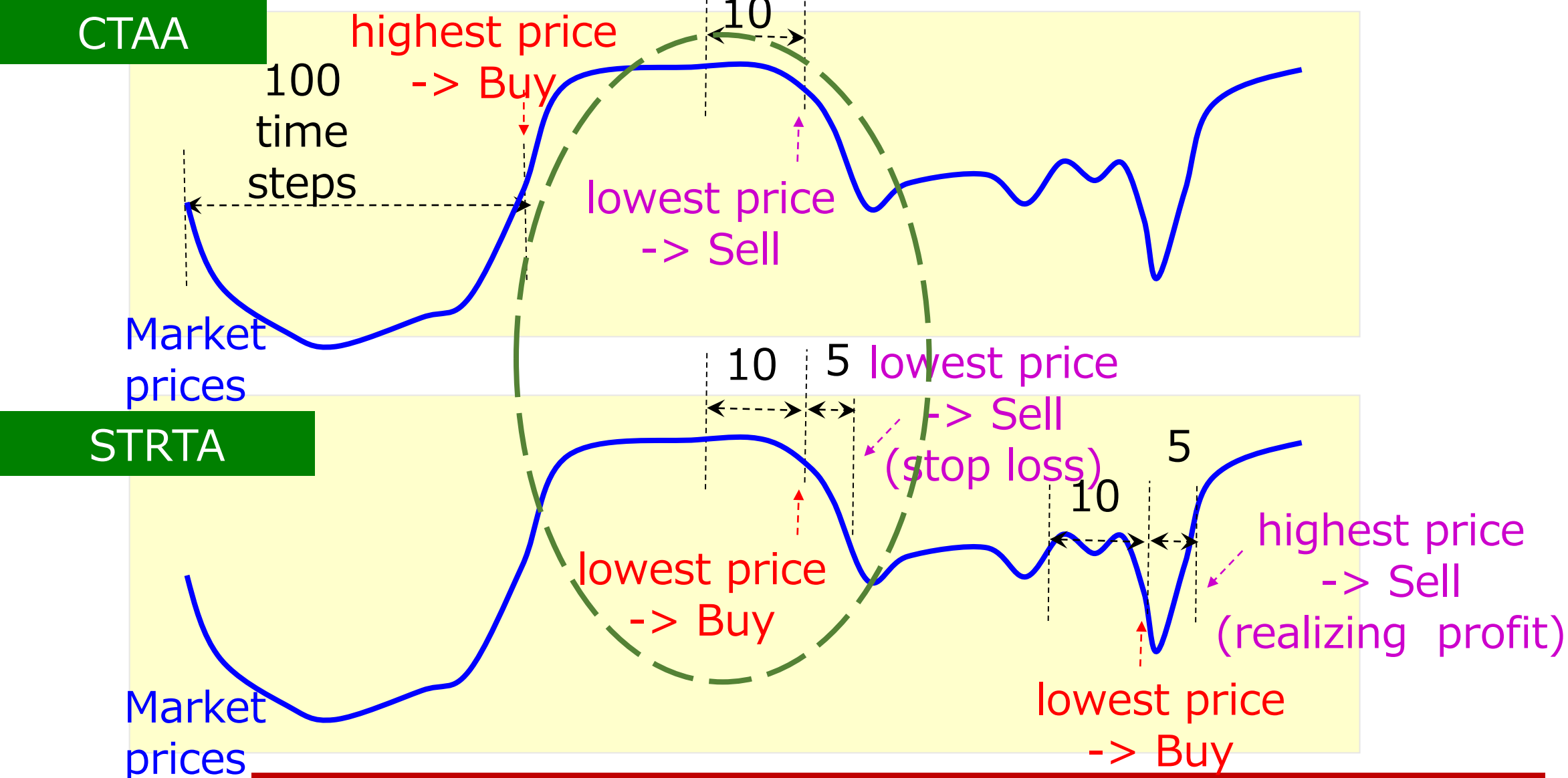
When STRTA has no share

* if historical lowest price for 10 time steps -> Buy -> holding +1 share
* if historical highest price for 10 time steps -> Sell -> holding -1 share

When STRTA holds +1 or -1 share (has some position)

* if historical lowest or highest price for 5 time steps
  -> closing the position -> holding NO share (stop loss or realizing profit)





The behavior of STRTA is opposite for that of CTAA
-> leads to reduce market impacts (trading costs) of CTAA
-> leads more benefit to CTAA (we can predict before simulation)

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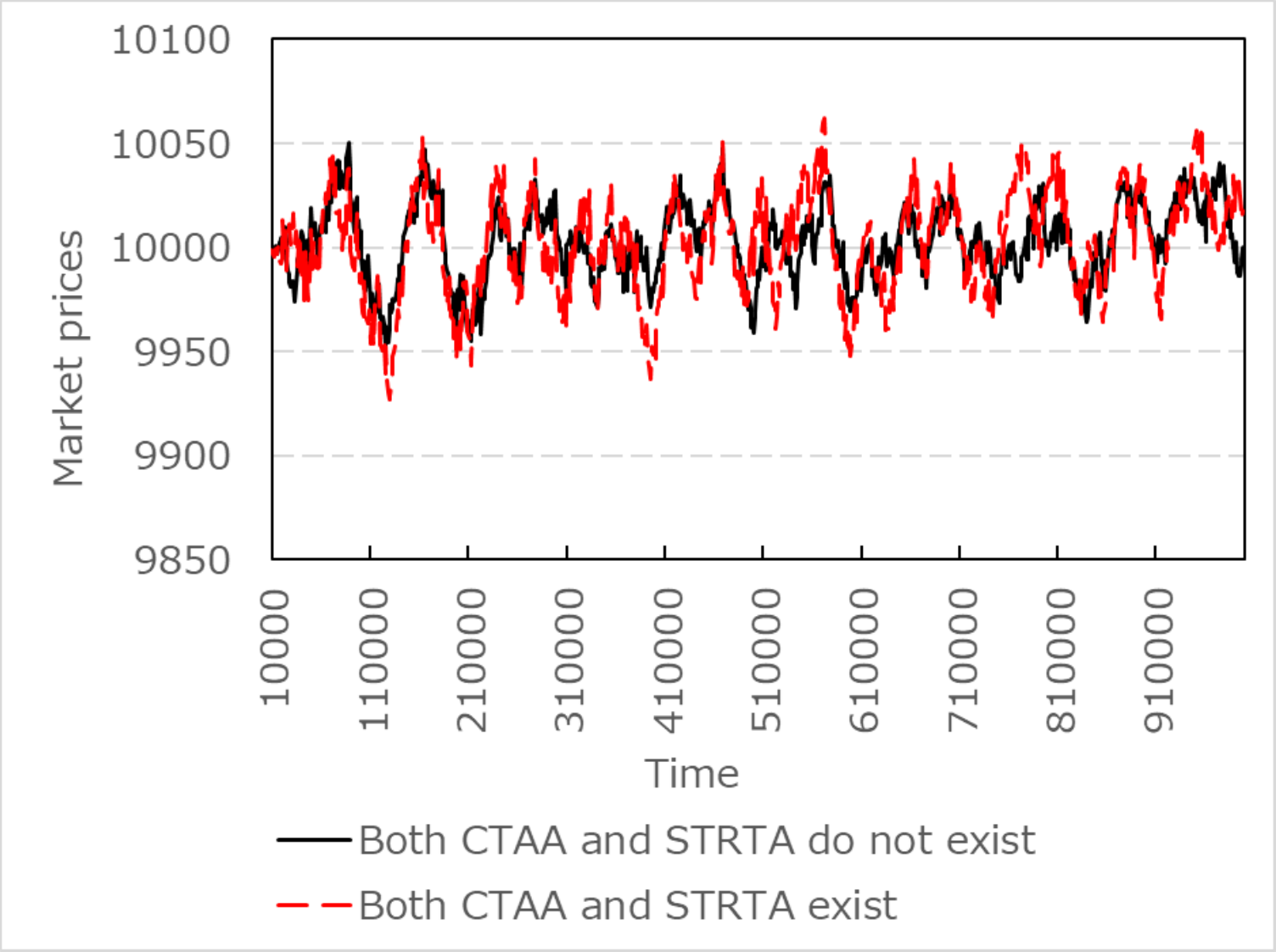
Time evolution of the prices



The two cases are not very different
The trades of them barely impact the prices

Profits

CTAA Profit		STRTA Exist	STRTA No exist
CTAA	Exist	105%	90%
	No exist	93%	79%

STRTA Profit		STRTA Exist	STRTA No exist
CTAA	Exist	293%	205%
	No exist	265%	185%

* The results for when “no exist” are calculated on the basis that the one would virtually trade and those orders would not change.

Both CTAA and STRTA earn more when the another one exists

Volume and Volatility

CTAA Volume		STRTA Exist	STRTA No exist
CTAA	Exist	892	865
	No exist	891	866

STRTA Volume		STRTA Exist	STRTA No exist
CTAA	Exist	1739	1633
	No exist	1685	1587

Volatility (returns for 100 steps)		STRTA Exist	STRTA No exist
CTAA	Exist	0.047%	0.038%
	No exist	0.041%	0.032%

Both CTAA and STRTA has more chances of trades when the another one exists

They have a mutually beneficial relationship

Mechanism of the mutually beneficial relationship

Shares Sell	Price	Shares Buy
2	103	
5	102	
1	101	
2	100	
1	99	
	98	1
	97	3
	96	2

Remove →

← Remove

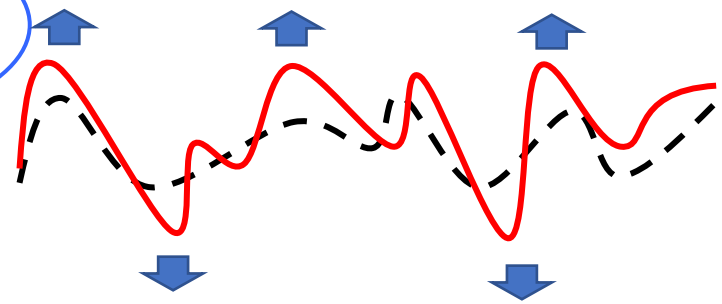
Place market order

Removing a waiting order

Larger variation of prices

Increased frequency of prices reaching maximum or minimum then more chances to trade

earns more



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Summary

- ✓ In this study, I built an artificial market model by adding a CTAA and STRTA to the prior model of Mizuta et al[2016] and investigated whether emerging STRTAs led to a decrease in CTAA revenue to determine whether STRTs prey on CTAs for profit.
- ✓ My results showed that CTAAs and STRTAs have more chances of trade and earn more when each other exist. Therefore, they have a mutually beneficial relationship.
- ✓ The CTAA and STRTA place a market order, which leads to a waiting order being removed from the order book. Decreasing waiting orders leads to other buy (sell) market orders executing with a waiting sell (buy) order of a higher (lower) price. This leads to a larger variation of prices and an increase in frequency that prices reach the maximum or minimum.
- ✓ Furthermore, the CTAA and STRTA have more chances to trade and earn more when each other exist, and increasing their trades leads to make more market orders and the strengthening of this cycle.

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LESSON

- ✓ When one investment strategy fails to work, new strategies, especially those that use new technologies or faster tradings, have tended to be blamed for a long time. Therefore, such arguments that new strategies are used to impede existing strategies should be discussed with particular suspicion.

- ✓ Since the second half of the 20th century, this tendency has become stronger, and the media have often criticized new investment strategies using new technologies, electronic trades, program trades, algorithm trades, high-frequency trades, and AI traders. However, these critics seem to be missing the point. These criticisms should be investigated using an artificial market model, which are considered future works.

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References

- [Clenow 2012] Following the Trend: Diversified Managed Futures Trading, Wiley, 2012
- [Mizuta 2016] Effects of price regulations and dark pools on financial market stability: An investigation by multiagent simulations, Intelligent Systems in Accounting, Finance and Management, vol. 23, no. 1-2, pp. 97–120, 2016.
- [Mizuta 2019] An agent-based model for designing a financial market that works well, arXiv https://arxiv.org/abs/1906.06000

  Slide: https://mizutatakanobu.com/2020CIFErb.pdf

  YouTube: https://youtu.be/rmlb72ykmlE
- My recent lecture slides https://mizutatakanobu.com/2021kyushu.pdf

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Appendix

It is possible that I answer questions using following slides,
my recent lecture slides https://mizutatakanobu.com/2021kyushu.pdf

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Stylized Facts

TABLE VII
STYLIZED FACTS

	CTAA	exist		not exist	
	STRTA	exist	not exist	exist	not exist
kurtosis or returns		3.46	3.80	3.67	3.99
	lag				
	1	0.131	0.127	0.138	0.128
autocorrelation	2	0.081	0.084	0.078	0.080
coefficient for	3	0.061	0.069	0.059	0.060
square returns	4	0.054	0.058	0.047	0.051
	5	0.046	0.053	0.042	0.043

The model of Chiarella (2002) is very simple but replicates long-term statistical characteristics observed in actual financial markets: a fat tail and volatility clustering.

In contrast, Mizuta (2013) replicates high-frequency micro structures, such as execution rates, cancel rates, and one-tick volatility, that cannot be replicated with the model of Chiarella (2002).

The simplicity of the model is very important for this study, because unnecessary replication of macro phenomena leads to models that are overfitted and too complex. Such models prevent understanding and discovery of mechanisms affecting price formation because of the increase in related factors.